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# MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS COOPER RESERVOIR SOUTH SULPHUR RIVER TEXAS

Public Health Service
Dallas, Texas

June 1961

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# MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

# COOPER RESERVOIR

# SOUTH SULPHUR RIVER

# TEXAS

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Springfield VA 22151

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

In Cooperation with the

DEPARTMENT OF THE ARMY
U. S. Army Engineer District - New Orleans, Louisiana

June 1961

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# I. INTRODUCTION

## Authority

A Memorandum of Agreement between the Departments of Health, Education, and Welfare and the Army, executed November 4, 1958, sets forth procedures for coordinating activities in planning and design of water use projects. In a letter dated August 12, 1959, the District Engineer, U. S. Army Engineer District, New Orleans, requested that the Public Health Service, under the terms of the Memorandum of Agreement, undertake water supply studies regarding the Cooper Reservoir, South Sulphur River, Texas.

## Purpose and Scope

This report presents data and information relevant to the determination of water requirements, to the year 2010, for municipal and industrial purposes in the area which may be served from the proposed Cooper Reservoir and how these needs may be met. Also, as requested by the Corps of Engineers, this report includes an estimate of the annual benefits which could be ascribed to storage allocated to water supply.

Consideration is given to locale, natural resources, and growth prospects, together with measures which may be necessary for the preservation of stream quality. The estimates of water demand are founded on forecasts of population increase and industrial expansion to the year 2010.

## Acknowledgments

Information and data have been obtained for this report from many persons, firms, organizations, and public officials, among which are the following:

U. S. Corps of Engineers, New Orleans District
U. S. Geological Survey, Austin, Texas
State Department of Health, Austin, Texas
Bureau of Economic Geology, Universtiy of Texas, Austin, Texas
Sulphur River Authority
Sulphur River Municipal Water District
City of Cooper, Texas
City of Commerce, Texas
Chamber of Commerce, Commerce, Texas
City of Sulphur Springs, Texas
Chamber of Commerce, Sulphur Springs, Texas
City of Greenville, Texas

The cooperation provided is acknowledged with sincere thanks.

# II. SUMMARY AND CONCLUSIONS

## Summary

1. The site of the proposed Cooper Dam is on the South Sulphur River in northeast Texas near the town of Cooper.

2. Potential users of water from the Cooper Reservoir include the Sulphur River Municipal Water District, the city of Greenville, and the Dallas-Fort Worth metropolitan area.

3. This report considers in detail present and future water demands of the area served by Sulphur River Municipal Water District and the city of Greenville. Details of demands for the Dallas-Fort Worth metropolitan area have been determined by other Public Health Service studies and are reported separately. 3,15/

4. The demographic and economic analyses of the three-county study area for the period from 1944 through 1960 show an increase in manufacturing, some gain in the retail and wholesale trade and service industries, a decline in agricultural employment and the value of crops sold, with the exception of livestock and livestock products which increased in value, and a constant or declining rate of production in mineral extraction and processing.

5. Populations of Cooper and Commerce declined slightly during the last decade, Sulphur Springs and Greenville increased, while all three counties showed a net population loss.

6. Future growth of the study area is related to a projected doubling of the national population with this area expanding to provide its share of goods to meet national requirements. Both agriculture and manufacturing are expected to grow; and service and other market-oriented industries will expand. Population of the four cities is expected to increase from a total of 36,000 in 1960 to 80,000 in the year 2010, or some 120 per cent.

7. Present water requirements of the study area are supplied from both surface and ground water sources, all having relatively small capacities, ranging from

a maximum of 4.5 mgd (million gallons daily) for Sulphur Springs to a minimum of less than 1 mgd each for Cooper and Commerce

8. Future water demands are projected on the basis of the anticipated growth in population and industry and take into consideration the probability that present supplies will decrease in capacity as time passes. Ground water sources are expected to supply only minor portions of the total demand.

## Conclusions

1. Potential demands for water from Cooper Reservoir, projected to develop within 50 years, are:

    a. 5.6 mgd for the Sulphur River Municipal Water District;

    b. 15.1 mgd for the city of Greenville;

    c. All available excess, up to the proposed capacity of 76 mgd, for the Dallas-Fort Worth metropolitan areas - with first use expected to begin about the year 2,000;

    d. Up to 11 mgd for low-flow augmentation, as a supplement to conventional waste treatment in maintaining stream quality.

2. It is recommended that the water supply pool in Cooper Reservoir be built to full size, that is, to assure a yield of 76 mgd.

3. The annual value of storage, for municipal and industrial water supply and related purposes, is estimated at $416,000 per year, or 1.5 cents per thousand gallons of yield at full utilization.

# III. DESCRIPTION OF PROJECT

The Sulphur River originates in Fannin County, Texas, at elevations around 700 feet above mean sea level and flows in an easterly direction, through the northeastern portion of Hunt County into Hopkins and Delta Counties, to the dam site. The drainage area above the site is 476 square miles. The watershed is very susceptible to erosion, consisting of rolling to hilly terrain in the Blackland Prairies. Most of the area is in cultivation of row crops.

## Cooper Reservoir

The Cooper Reservoir project, South Sulphur River, Texas, was authorized under an act of August 3, 1955 (Public Law 218, 84th Congress, 1st Session) substantially in accordance with the construction plans recommended in the report of the Chief of Engineers in House Document Numbered 488, Eighty-third Congress, Second Session. The recommendation provides for a flood-control dam and makes possible local participation in water conservation storage for municipal and industrial use.

The dam site is located in Delta and Hopkins Counties, Texas, at river mile 23.2 on the South Sulphur River (Figure 1). The reservoir will be entirely within Delta and Hopkins Counties.

The average annual rainfall over the drainage area is about 39 inches. The average annual run-off at the dam site has been estimated by the Corps of Engineers to be 212,800 acre-feet (190 mgd) based on hydrographic data for the period October 1, 1923, to December 31, 1957, inclusive. The average annual net loss to be expected over the Cooper Reservoir surface due to the combined effects of evaporation and rainfall has been estimated by the Corps of Engineers to be about 10 inches. 2/

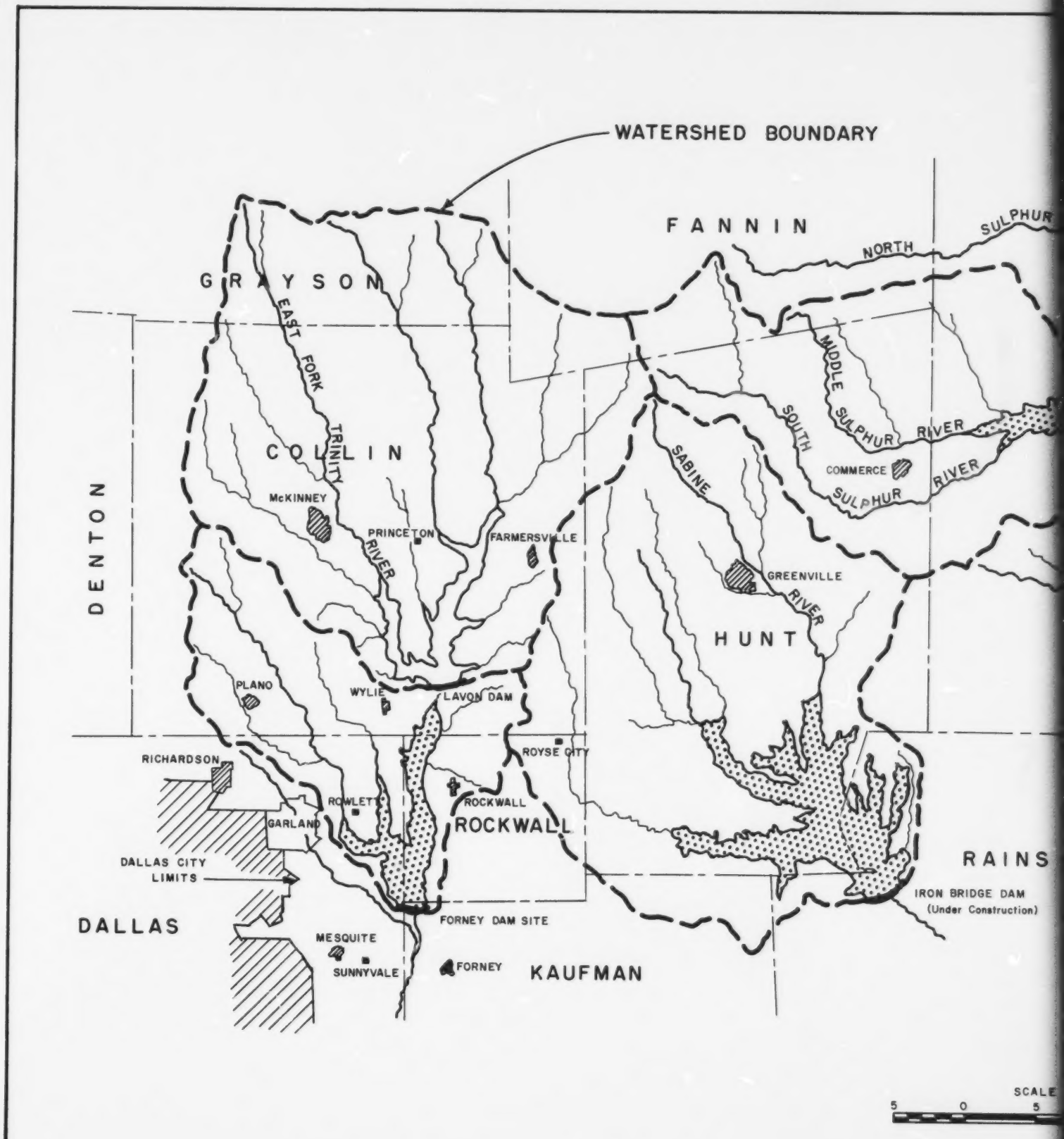
A storage volume of 115,000 acre-feet for water supply has been considered in design studies for the project. This tentatively selected water-supply pool has been reserved for participation by local interests in the project. According to studies made by the Corps of Engineers, this storage will provide a firm yield of about 76 million gallons per day. Corresponding firm yields for lesser storage volumes are given in Table 1.

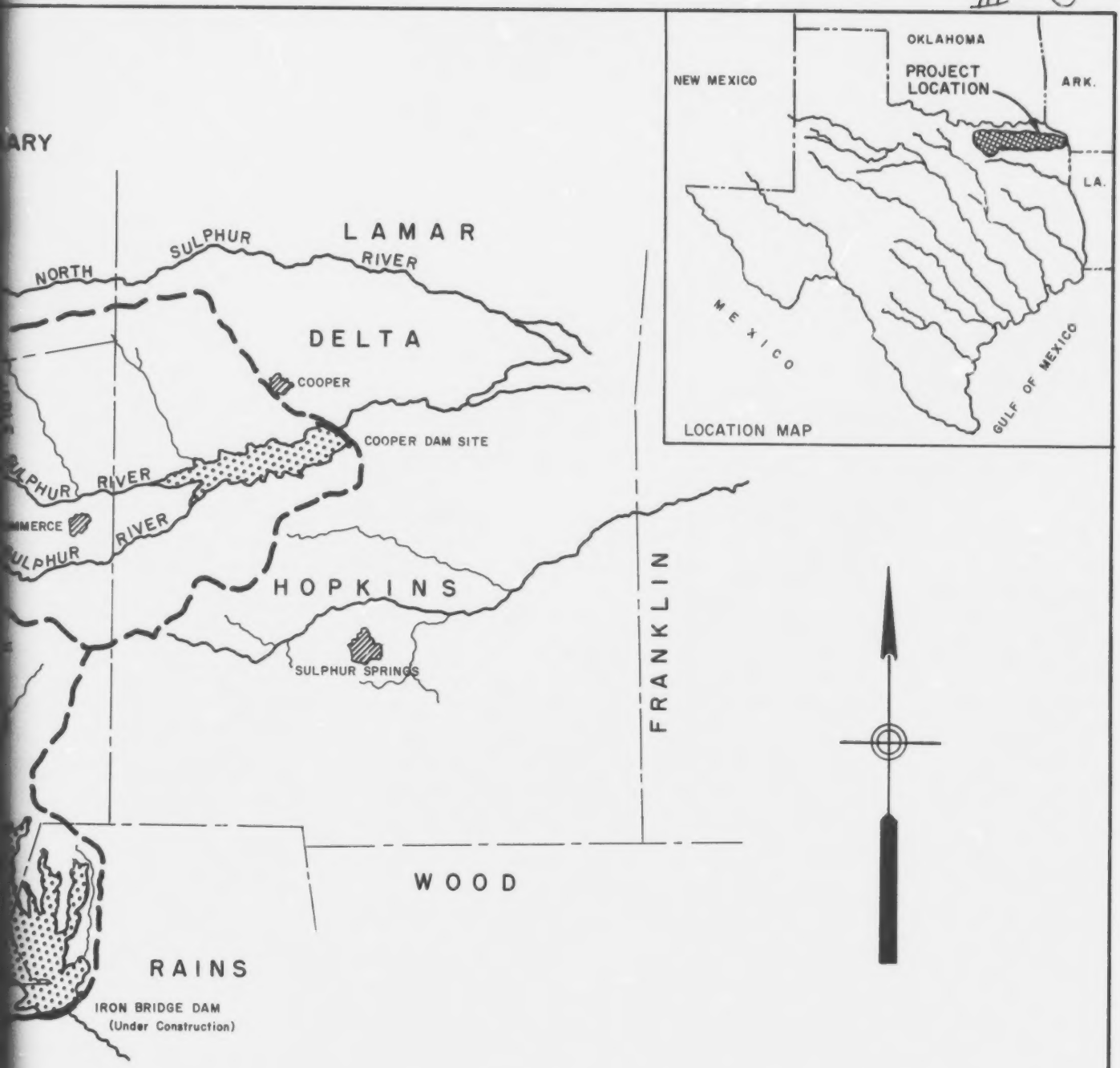
The water of the South Sulphur River is of high quality, suitable for general municipal and industrial use. The Appendix (Exhibit A) is a compilation of chemical analyses of water samples collected from the river at a sampling station about three miles below the dam site.

Table 1 1/

Water Supply Storage vs. Yield

| Pool Capacity (Acre-Feet) | Top Elevation (Ft. above MSL) | Water Supply Yield (mgd) |
|---|---|---|
| 115,000 | 429.0 | 76.1 |
| 75,400 | 425.5 | 56.0 |
| 65,700 | 424.5 | 51.8 |
| 56,700 | 423.6 | 44.3 |
| 28,800 | 419.6 | 20.1 |
| 17,000 | 417.8 | 17.0 |
| 12,000 | 417.0 | 12.0 |


WATERSHED BOUNDARY
FANNIN
NORTH SULPHUR
GRAYSON
EAST FORK TRINITY
MIDDLE SULPHUR RIVER
SOUTH SULPHUR RIVER
SABINE
COMMERCE
COLLIN
DENTON
McKINNEY
PRINCETON
FARMERSVILLE
RIVER
GREENVILLE
HUNT
PLANO
WYLIE
LAVON DAM
ROYSE CITY
RICHARDSON
ROWLETT
ROCKWALL
ROCKWALL
GARLAND
DALLAS CITY LIMITS
RAINS
IRON BRIDGE DAM
(Under Construction)
FORNEY DAM SITE
DALLAS
MESQUITE
SUNNYVALE
FORNEY
KAUFMAN
SCALE
5 0 5




COOPER RESERVOIR

WATERSHED MAP

DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE 1

# IV. DESCRIPTION OF STUDY AREA

The localities of potential demand for water from storage in Cooper Reservoir are:

1. The local area consisting of the member cities of the Sulphur River Municipal Water District;

2. The city of Greenville and environs;

3. The Dallas-Fort Worth Metropolitan Complex, including the cities served by the North Texas Municipal Water District, and others.

This report has considered in detail only the first two of these three areas. The third area has been studied by the Public Health Service in connection with other reservoir projects, and results are reported separately. 3,15/

The Sulphur River Municipal Water District, created by a legislative act approved May 12, 1955, is composed of the cities of Cooper, Commerce, and Sulphur Springs, Texas. It does not include any area outside of these three cities; however, under certain procedures, other territory in Delta, Hunt, Hopkins, and Franklin Counties may be annexed to the District. In addition to the power to acquire rights in and to conservation storage in Cooper Reservoir, subject to contractual arrangements with the Corps of Engineers, the District is empowered to construct or acquire all works and facilities necessary for the purpose of diverting, storing, processing, and transporting water to cities and others for municipal and industrial purposes. The legislative act stipulates that none of the powers of the District shall extend outside of Delta, Hunt, Hopkins, and Franklin Counties. On the basis of this authority, it is assumed that this District can represent all local interests, in so far as Cooper Reservoir is concerned, in these four counties.

While the Sulphur River Municipal Water District, at the present time, consists of the three cities of Cooper, Commerce, and Sulphur Springs, Texas, the District could be extended to include the city of Greenville, Texas, which is located about 35 miles southwest of the Cooper Dam site.

# V. POPULATION AND ECONOMY

The population increase and industrial growth of the cities involved and their forecasted water demands will depend in large part upon the presence of natural resources, the extent and present pattern of industrial development in the area, and the growth of the market. A demographic and economic analysis of the three counties of Hopkins, Hunt, and Delta, within which the study area lies, has been made to determine past growth patterns and provide a basis for projecting future potentials.

## Extractive Industries

### Minerals

The extraction of mineral resources is of minor importance in the economy of the area. Delta County reports no mineral production, while Hunt County has shown an erratic amount of production, with the overall trend since 1952 being downward. The total production for the year 1957 amounted to $49,100. Hopkins County has shown a constant production of minerals averaging $7,351,000 each year since 1952. See Table 2.

Table 2 5/

Value of Mineral Production
Delta, Hunt, and Hopkins Counties, Texas
1952 - 1958

(Figures in Millions of Dollars)

| Counties | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|
| Delta | -- | -- | -- | -- | -- | -- | -- |
| Hunt | 0.13 | 0.123 | 3.200 | 0.07 | 0.441 | 0.049 | -0- |
| Hopkins | 7.493 | 7.904 | 7.795 | 7.939 | 8.049 | 5.759 | 6.388 |

Petroleum, natural gas, and natural gas liquid are the primary products in Hopkins County, while sand and gravel account for the bulk of the mineral production in Hunt County.

### Agriculture

The role of agriculture in the economy of the area has been declining. Not only has the number of persons employed been decreasing, but the number of farms in the area has decreased from 10,595 in the year 1944 to 6,361 in the year 1954. Along with this reduction in farms has been a decline in the acreage of cropland harvested. This acreage was 456,766 in the year 1944, dropping to 338,636 in 1954.

The value of crops sold increased between the years 1944 and 1949, but decreased between the years 1949 and 1954, while the value of livestock and livestock products sold had a compensating trend. The latter increased from $4,615,000 in 1949 to $5,979,000 in 1954.

The combined value of both crops and livestock, however, shows a decrease of 36 per cent for Delta and Hunt Counties and 13 per cent for Hopkins County between 1949 and 1954. Annual totals appear in Table 3.

Table 3 6/

Value of Crops, Livestock and Livestock Products Sold
Delta, Hunt, and Hopkins Counties, Texas
1944, 1949, and 1954

(Figures in Millions of Dollars)

| Year | Value of Crops Sold | Value of Livestock and Livestock Products Sold | Total |
|---|---|---|---|
| | | Delta County | |
| 1944 | 2.081 | 0.538 | 2.619 |
| 1949 | 3.44 | 0.524 | 3.964 |
| 1954 | 1.897 | 0.631 | 2.528 |
| | | Hunt County | |
| 1944 | 5.735 | 1.985 | 7.720 |
| 1949 | 8.184 | 1.578 | 9.762 |
| 1954 | 4.494 | 1.615 | 6.109 |
| | | Hopkins County | |
| 1944 | 2.329 | 2.637 | 4.966 |
| 1949 | 3.074 | 2.513 | 5.587 |
| 1954 | 1.171 | 3.533 | 4.904 |

## Manufacturing

The manufacturing base of the area has had an expanding trend. There has been an increase in the number of plants in the study area since 1947. Table 4 shows the total number of manufacturing firms in the area for the years 1947, 1954, and 1960.

Table 4 7,8/

Number of Manufacturing Firms
Delta, Hunt, and Hopkins Counties, Texas
1947, 1954, and 1960

| | 1947 | 1954 | 1960 |
|---|---|---|---|
| Delta | 4 | 2 | 2 |
| Hunt | 38 | 50 | 58 |
| Hopkins | 17 | 21 | 28 |

The total number of employees for the year 1954 was approximately 2,700. The 15 additional manufacturing firms have increased the total employees to approximately 3,500. In 1960 there were 31 manufacturing firms having 20 or more employees. These firms were spread over 12 industrial categories, giving a wide industrial base. Table 5 gives a tabulation of all firms and their categories for the years 1947, 1954, and 1960.

Table 5 8/

Number of Firms by Size and Type of Manufacturing
Delta, Hunt, and Hopkins Counties, Texas
1947, 1954, and 1960

| Type | Number with 1-19 Employees | | | Number with 20-99 Employees | | | Number with 100 and over Employees | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1947 | 1954 | 1960 | 1947 | 1954 | 1960 | 1947 | 1954 | 1960 |
| Food and Kindred Products | 18 | 19 | 16 | 7 | 6 | 8 | 2 | 1 | 1 |
| Textile Mill Products | -- | 3 | -- | -- | -- | -- | 1 | -- | -- |
| Apparel and Related Products | -- | 1 | 3 | 3 | 4 | 3 | 1 | 3 | 4 |
| Lumber and Wood Products | 2 | 3 | 1 | -- | 1 | 1 | -- | -- | -- |
| Furniture and Fixtures | 1 | 3 | 4 | -- | -- | 2 | -- | -- | -- |
| Printing and Publishing | 10 | 10 | 9 | 3 | 3 | 3 | -- | -- | 1 |
| Chemical Products | -- | -- | 3 | 5 | 3 | 1 | -- | -- | -- |
| Petroleum and Coal Products | 1 | 1 | -- | -- | -- | 1 | -- | -- | -- |
| Leather and Leather Products | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| Stone, Clay and Glass Products | 2 | 3 | 5 | 1 | -- | 1 | -- | -- | -- |
| Primary Metal Products | 1 | -- | 1 | -- | -- | -- | -- | -- | -- |
| Fabricated Metal Products | 1 | 1 | 5 | -- | -- | -- | -- | -- | 1 |
| Machinery, except Electrical | -- | 4 | 5 | -- | -- | 1 | -- | 1 | -- |
| Electrical Machinery | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| Transportation Products | -- | 1 | 2 | -- | -- | 1 | -- | 1 | 1 |
| Miscellaneous Manufactures | -- | 1 | 2 | -- | -- | -- | -- | -- | -- |
| TOTAL | 36 | 50 | 57 | 19 | 17 | 22 | 4 | 6 | 9 |

## Trade and Service Establishments

Retail and wholesale trade, and selected services, have shown a slight increase in volume of business activity since 1948. Table 6 shows this growth in sales in retail and wholesale trade, and service establishments, for the three counties of the area. The value of sales, when adjusted for the change in the value of the dollar, shows a very small decrease between the years 1954 and 1958. However, an examination of the population shows a decrease in total population of a greater proportion, which would suggest that the area is serving a greater proportion of the market or a larger market area.

Table 6 9/

Total Sales Volume of Retail and Wholesale Trade and Selected Services

| | 1948 | 1954* | 1958* |
|---|---|---|---|
| Delta | $ 6,331,000 | $ 4,411,000 | $ 4,254,000 |
| Hunt | 56,787,000 | 55,100,000 | 54,892,000 |
| Hopkins | 18,243,000 | 28,017,000 | 28,136,000 |
| TOTAL | $81,361,000 | $87,528,000 | $87,282,000 |

*Adjusted to the 1948 Value of the Dollar

## Population

Two diverse directions have been manifested in the population trends in the three-county area. From 1930 to 1960, the combined population of the four cities under study, Cooper, Commerce, Greenville, and Sulphur Springs, in the three-county area has increased 50 per cent, whereas the combined population of the three counties has decreased 31 per cent.

The general trend of the area is one of decreasing total population of the counties and an increasing municipal population, although the census shows that the cities of Cooper and Commerce have decreased in population, while Greenville and Sulphur Springs increased. These trends are shown in Tables 7 and 8.

Table 7 10/

Population - Counties and Cities

| Year | Delta County | Hopkins County | Hunt County | Cooper | Commerce | Sulphur Springs | Greenville |
|---|---|---|---|---|---|---|---|
| 1890 | 9,117 | 20,572 | 31,885 | 629 | 810 | 3,038 | 4,330 |
| 1900 | 15,249 | 27,950 | 47,295 | 1,518 | 1,800 | 3,635 | 6,860 |
| 1910 | 14,566 | 31,038 | 48,116 | 1,513 | 2,818 | 5,151 | 8,850 |
| 1920 | 15,887 | 34,791 | 50,350 | 2,563 | 3,842 | 5,558 | 12,384 |
| 1930 | 13,138 | 29,410 | 49,016 | 2,023 | 4,267 | 5,417 | 12,407 |
| 1940 | 12,858 | 30,274 | 48,793 | 2,537 | 4,699 | 6,742 | 13,995 |
| 1950 | 8,964 | 23,490 | 42,731 | 2,350 | 5,889 | 8,991 | 14,697 |
| 1960 | 5,806 | 17,999 | 39,304 | 2,192 | 5,772 | 9,166 | 19,055 |

Table 8 10/

Combined Populations of Counties and Cities

| Year | Total Population of 4 Cities Under Study | Total Population of Counties excluding 4 Cities Under Study | Total Population of Counties |
|---|---|---|---|
| 1890 | 8,807 | 52,767 | 61,574 |
| 1900 | 13,813 | 76,681 | 90,494 |
| 1910 | 18,332 | 75,388 | 93,720 |
| 1920 | 24,347 | 76,681 | 101,028 |
| 1930 | 24,114 | 67,450 | 91,564 |
| 1940 | 27,973 | 63,592 | 91,925 |
| 1950 | 31,927 | 43,258 | 75,185 |
| 1960 | 36,185 | 26,924 | 63,109 |

## Future Growth

The population of the Nation is expected to double between 1960 and 2010. This will mean a vast increase in the need for goods and services in the next fifty years. All parts of the Nation will continue to contribute to the needs, but the rate of increase in production will not be uniform in all areas. The more favorably a community is endowed with factors which enhance its ability to produce and distribute goods and services, the greater will be its likelihood of growth. This section will cite the growth expectations of the study area in the extractive, manufacturing, and service industries, and the resultant population projections.

The basic economy of the study area is agricultural, with both crops and livestock playing an important part. As in most agricultural areas, the rural population is continually decreasing due to mechanization, the consequent employment decline, and the shifting of farm population to urban areas. In the last decade, there has been an increase in the production of livestock and livestock products with a reduction of cultivated crops. The study area has also been a large producer of dairy goods. This trend is expected to continue with livestock and dairy products becoming more important.

The extraction of minerals will continue to form an important part of the economic base of the area. Based on estimated reserves of petroleum and natural gas, it is expected that production will continue at a fairly constant rate, with no significant increase anticipated. The extraction of other natural resources, such as clays, sand and gravel, is expected to increase. The resultant composite trend of employment in the extractive industries is expected to remain stationary at the 1960 level.

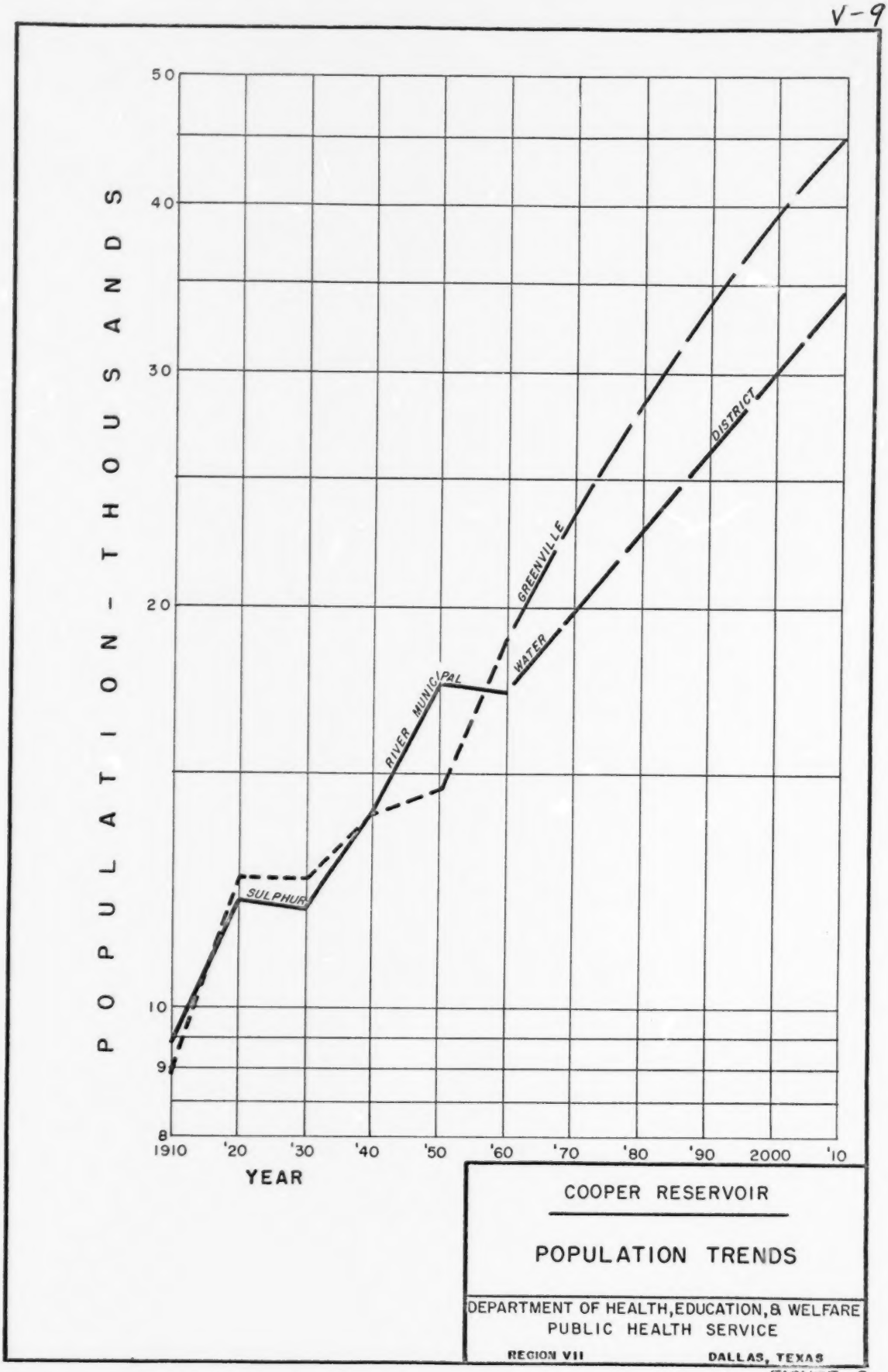
The growth and increased diversification of the manufacturing base will continue. Production is expected to increase in resource-based industries, particularly in food processing, the manufacturing of clay products, and generation of electric energy. In addition, market-oriented manufacturing plants will develop as population in the market area increases - the most promising being apparel, metal products, and machinery. It is anticipated that the total employed in manufacturing will triple by the year 2010, and employment in trade and service establishments will likewise continue to grow.

The general climate for industrial and commercial growth in the study area is favorable. Local as well as national markets are expanding. Good transportation facilities are available. All four cities are served by railroads and an excellent highway system. Fuel and power are available at relatively low cost and a ready supply of labor can be assured.

Past trends and future projections of population are shown on Figure 2. In making these projections, consideration was given to: (1) the past record and present population of cities involved; (2) the expected growth rates of the nation as a whole and of the State of Texas; (3) the potential industrial development which could be expected from the natural resources of the area in the presence of adequate and assured water supply; (4) the potential for market-oriented manufacturing not based primarily on local natural resources; and (5) the increase in associated trade and service activities.

Total projected population for the three cities comprising Sulphur River Municipal Water District, in 2010, is 34,700. From the present (1960) population, this reflects a growth rate of 1.4 per cent compounded annually, which is slightly less than the assumed national average rate of 1.5 per cent.

Projected population for the city of Greenville in 2010 is 45,000. This projected growth rate, from a 1960 population of 19,055, is 1.75 per cent annually, which is equal to the average rate projected for the State of Texas as a whole.




COOPER RESERVOIR

POPULATION TRENDS

DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE

REGION VII DALLAS, TEXAS

FIGURE 2

# VI. WATER SUPPLY AND DEMAND

## Present Supplies

The present water supply sources of the participating cities of the Sulphur River Municipal Water District are both ground water and surface water from reservoirs on tributaries of the Sulphur River.

The city of Cooper, Texas, with a 1960 population of 2,192 persons, obtains its water from a surface reservoir southeast of town which collects water from a drainage area of not more than four square miles. The city ran out of water during the recent drouth, particularly in 1956, and was given aid by the Federal Civil Defense Administration. Due to joint efforts of the Administration and the city, two wells were constructed in the alluvium bottoms of South Sulphur River and over 20,000 feet of 6-inch water line were placed in operation between these wells and the city water mains. This served as a temporary water supply until the drouth was over in 1957. Since then, the 6-inch water line has been abandoned and partly taken up, leaving the city solely dependent at present upon its small surface water reservoir. On the basis of an appraisal of its long-term reliability, it is estimated that the present supply source will furnish 0.1 mgd by the year 2010.

The city of Commerce, Texas, with a 1960 population of 5,772 persons, obtains its water entirely from six wells drilled to a depth of 425 to 485 feet. The combined pumping capacity of the wells is about 1.4 mgd. It is concluded in a memorandum in files of the U. S. Geological Survey, Ground Water Branch, Austin, Texas, prepared in cooperation with the Texas Board of Water Engineers 13/, that "No important supplies of water of good quality are likely to be encountered below the present producing sand at Commerce....," and further, "The water level seems to have been in approximate equilibrium, probably because the rate of withdrawal has been more or less constant." At the time the investigation of this memorandum was made (June, July, 1959), the city was supplied from two wells which yielded about 0.4 mgd each. Other investigations by the Ground Water Division of the Texas Board of Water Engineers in 1956 have indicated, according to the files of the Board, that the safe production rate of ground water had been reached at Commerce and that additional production from this source would tend to dewater the producing sands. It was advised that any additional water source for Commerce be provided by surface water reservoir. On the basis of an appraisal of the long-term reliability of the present water supply, it is estimated that the present average rate of withdrawal of 0.5 mgd can be maintained to the year 2010.

The city of Sulphur Springs, with a 1960 population of 9,166 persons, obtains its water from a surface water reservoir on White Oak Bayou, a large tributary to the Sulphur River. The White Oak Bayou impoundment is capable of producing approximately 4 to 5 million gallons per day. The present average use is 0.86 mgd. On the basis of an appraisal of the long-term reliability of the present water supply, giving allowance for sedimentation, it is estimated that by the year 2010 a yield of 3 mgd may be realized.

The city of Greenville, with a 1960 population of 19,055 persons, obtains its water from a series of five off-channel surface water reservoirs. The water is channeled to the reservoirs by an earthen canal from Cow Leech Fork, a tributary of the Sabine River. The impoundment of the series of reservoirs has an estimated firm yield of approximately 2.7 mgd. The present average daily consumption is about 2.5 mgd.

## Projected Needs

Projections of future water requirements for a given area for municipal and industrial purposes are influenced not only by the trends purely of a local nature but also by the indicated trends of regional, state, and national scope. This is particularly true of the area under study since it is surrounded on all sides except to the immediate east by areas that can expect growth by industrial expansion. The city of Paris, some 30 to 40 miles north of the study area, has had an industrial expansion which will cause an increase in population and water demand. The metropolitan area of Dallas, located 60 to 70 miles southwest of the project area, is an expanding municipal and industrial area. There is reason to believe that, because of the industrial expansion of the southwestern part of the Nation, the study area will be of interest to industries seeking new plant sites if an adequate water supply is made available by Cooper Reservoir and if satisfactory disposal of treated wastes is possible.

### Municipal Water Demand

Projections of water requirements for municipal use are based on population growth patterns and consideration of the present and past water consumption of the area. It is expected that consumption of water by a city on a per person basis will increase as the city increases in size and more services and goods are produced in the city for satisfying local needs.

Table 9 presents data on water consumption per person for cities in north and east Texas. The data in this table are for treated water pumpage, as reported for the year 1957. Data are not readily available for other years. The year 1957 was an unusually wet year throughout

practically all of Texas; and, for this reason, the data of Table 9 should represent a minimum water use year. It does, however, indicate in general that in this area the larger the town or city, the larger the per capita daily consumption of water.

Table 9 14/

Rates of Water Consumption Per Person in 1957
Cities of North and East Texas

(As Reported to the Public Health Service)

| City | Population Served | Total Water Use (Gals. per cap. per day) | Water Source |
|---|---|---|---|
| Athens | 7,025 | 102 | Wells |
| Bonham | 8,000 | 100 | Wells |
| Clarksville | 4,950 | 81 | Wells |
| Denison | 21,780 | 160 | Lake |
| Denton | 28,000 | 107 | Lake & Wells |
| Grapevine | 3,200 | 84 | Wells |
| Greenville | 24,850 | 137 | Lake |
| Longview | 47,000 | 75 | Lake |
| Mount Vernon | 2,220 | 80 | Lake |
| Paris | 23,760 | 102 | Lake |
| Sherman | 28,350 | 141 | Wells |
| Sulphur Springs | 12,000 | 72 | Lake |

For estimating municipal water demands corresponding to the projected populations in the year 2010, a per capita figure of 150 gallons per day has been adopted. This figure represents the quantity of raw water which must be delivered to treatment plants. It includes distribution system losses, unaccounted for water, and treatment plant attenuation.

Projected water demands, of the Sulphur River Municipal Water District and the city of Greenville, are given in Table 10. The municipal component includes residential, public, and commercial use, plus those industrial uses which can reasonably be reflected to an overall per capita use figure. To arrive at total demands, it is necessary to add the projected water requirements of special water using industries.

Table 10

Projected Water Demands in the Year 2010

(All figures are in mgd)

| | Sulphur River Municipal Water District | City of Greenville |
|---|---|---|
| Municipal Water Demand | 5.2 | 6.8 |
| Industrial Water | 4.0 | 11.0 |
| Total M & I Demand | 9.2 | 17.8 |

Industrial Water

Significant water demands, in addition to the municipal component, may be expected to develop in two major categories - food processing industry and thermal-electric power generation. As previously stated, the resources and economic environment are conducive to growth in food processing activity. The provision of a water supply of ample quantity and assured availability could be an added stimulant.

In regard to power generation, investigation discloses two possible users of water from the Cooper Reservoir - the existing plant of the Texas Electric Power Company near Talco and a plant proposed for construction at Mount Pleasant, Texas, by the Southwestern Electric Power Company.

The Talco plant obtains water from the Sulphur River, relying on off-channel storage at the plant to supplement natural flows. It is reported that present water use is considerably less than the 10,000 acre-feet (9 mgd) allowed by their permit. The future needs of this plant should be considered in the study of Cooper Reservoir because of the effect of reservoir regulation on the regimen of downstream flows.

At the present stage of planning of the proposed power plant at Mount Pleasant, it is understood that sources other than Sulphur River will be utilized for its water supply.

From the limited present base, it is difficult to predict accurately the extent and pattern of future industrial growth. Based on the foregoing discussion, an industrial demand of 15 mgd is projected. It is assumed that this demand will be distributed as shown in Table 10. As to when the demand will occur, it is probable that a substantial portion would develop shortly after the

large water supply of Cooper Reservoir became available. For example, officials of Greenville state that an industry requiring about 7.5 mgd is awaiting only the assurance of water supply before locating there.

## Future Supply Plans

Table 11 presents a summary of the projected water demands, the estimated long-range capability of present sources, and the amount of new source water which might be supplied from storage in Cooper Reservoir. From this table, it is seen that the potential demand on the reservoir by the Sulphur River Municipal Water District may range from 5.6 to 9.2 mgd, depending on whether present sources are continued in service or abandoned in favor of the single source - to avoid duplication of treatment plant operations.

Table 11

Water Demand in 2010 And Potential Supply

(All figures in mgd)

| Locality | Projected M & I Demand | Existing Supply | Needed From New Sources |
|---|---|---|---|
| SRMWD* | 9.2 | 3.6 | 5.6 |
| Greenville | 17.8 | 2.7 | 15.1 |
| TOTAL | 27.0 | 6.3 | 20.7 |

*Sulphur River Municipal Water District

The city of Greenville, although not a member of the Water District, has indicated interest in Cooper Reservoir as a possible future source. The city has a contract to obtain up to 15 mgd from Iron Bridge Reservoir. Iron Bridge Dam, now nearing completion on the Sabine River, is being constructed by the Sabine River Authority, primarily for additional water supply to the city of Dallas.

Studies are concurrently being made by the Public Health Service of projected water demands of the Dallas - Fort Worth metropolitan complex - including the area served by the North Texas Municipal Water District. These studies indicate that meeting the needs of the area will require full development, by the year 2000, of all surface and ground water sources in the Upper Trinity Watershed plus Iron Bridge Reservoir on the Sabine River. Beyond that time, as growth continues, the search for water will be extended farther. From a regional viewpoint, therefore, it is logical to assume that any excess water available at Cooper Reservoir will be transported westward to meet growing deficiencies. In the regional water supply picture, it is of little consequence whether Iron Bridge water goes to Greenville and Cooper water goes to the Dallas area, or vice versa.

It is the opinion of the Public Health Service that the exportation of water from storage provided in Cooper Reservoir to meet future requirements to the west of the Sulphur River basin, will begin about the year 2000. As previously stated, this is based on a regional study of water supply and demand and the best information available at this time. We are advised that the Texas Board of Water Engineers holds a different view. According to the Board's Chief Engineer, studies made by their Planning Division indicate that the North Texas Municipal Water District, serving northeast Dallas County and several neighboring cities, will need supplemental water in addition to the yield from an enlarged Lavon Reservoir before 1980.

# VII. WATER QUALITY CONSIDERATIONS

## The General Problem

The use of water will usually result in the production of liquid wastes which, even after a high degree of treatment may lower the quality of receiving waters. Fortunately, streams, rivers, lakes, etc., have some capacity to receive waste materials and still maintain qualities that will not prevent downstream uses. When the waste load remaining after reasonable removal of oxidizable material by treatment still exceeds the assimilative capacity of the receiving stream, other methods of preserving stream quality must be considered, among them being increasing the flow of the stream during critical periods of low flow or high water temperature. Low-flow augmentation enlarges the assimilative capacity of the stream and permits increased reuse of the waters while maintaining the prescribed stream quality. Without this augmentation, the water quality will either deteriorate to below the desired level or additional treated waste discharges cannot be permitted and the ultimate development of the area will be restricted.

Recognizing augmentation of low stream flows as one means of preserving stream quality, estimates have been made of their magnitude since they may be a part of the water demand from the Cooper Reservoir when unimpounded flows in the South Sulphur River have an insufficient assimilative capacity. Although the final determination and acceptance of stream quality must come from the Division of Water Pollution Control, Texas State Department of Health, it is expected that the maintenance of stream flows at levels indicated will result in quality conditions reasonably acceptable to this agency.

## Watershed Protection

The city of Commerce is located above the proposed Cooper Reservoir and discharges its wastes, after treatment, into the South Sulphur River. This constitutes a potential future hazard to the quality of water in the reservoir. This problem should be recognized and plans made to take necessary measures to protect both the stream and the stored water. Among the measures which might be effective are: lagoons for further "polishing" of treatment plant effluents; holding basins in which wastes may be stored during times of low stream flow for release during floods; and use of effluent for irrigation.

The food processing plants which are envisioned as likely to enter the area, produce organic wastes that are especially high in biochemical oxygen demand (BOD). Location of such plants on the watershed above the dam should be discouraged unless their wastes are piped to a discharge point below the dam.

## Low-Flow Augmentation

Downstream from the reservoir, the preservation of stream quality can be materially aided by releases of stored water to augment natural runoff during low-flow periods. For estimating the desirable minimum stream flows to be maintained, it has been assumed that a major portion of the wastes from projected food processing industry together with the municipal waste from the city of Cooper will be discharged to the river below the dam. It is assumed that treatment prior to discharge will remove about 95 per cent of the industrial, and 90 per cent of the municipal, BOD. On this basis, releases to maintain an average annual flow rate of about 11 mgd would be required to assimilate residual wastes and maintain the dissolved oxygen content of the stream above four parts per million. The bulk of this release would be needed in the three summer months, during which required flow rates would be about three times the annual average.

The provision of storage in Cooper Reservoir for the full optimum yield will make it possible to maintain the desirable augmentation flows, until such time as the demands for municipal and industrial supply must take precedence. When that time is reached (about the year 2000), other means will have to be resorted to, such as a higher degree of treatment or the exclusion of part of the wastes from the stream.

Fortunately, in this case, the principal waste problem is one of decomposable organics. There is reason for optimism, in that there are possibilities that treatment methods will be improved to such a degree as to virtually eliminate the need for dilution water. The method which appears most promising is waste stabilization lagoons to further improve wastes that have already been subjected to treatment to reduce oxidizables 90 per cent.

# VIII. VALUE OF STORAGE

## Amount of Storage Needed

In review, the water demands projected to develop within 50 years for water from Cooper Reservoir are as follows:

1. 5.6 mgd for the cities of the Sulphur River Municipal Water District, as a supplement to existing sources;

2. 15.1 mgd for the city of Greenville, as a possible substitute for Iron Bridge Reservoir, in supplementing existing sources;

3. All available excess, up to the proposed capacity of 76 mgd, for the Dallas metropolitan area;

4. An interim use, until needed for higher-priority purposes, of a portion of the excess yield for low-flow augmentation - up to about 11 mgd.

It is concluded that, when Cooper Reservoir is built, its design should incorporate the maximum economically feasible amount of storage for water supply purposes. Storage in the amount necessary to provide a firm yield of 76 mgd has been assumed in the following estimate of annual monetary benefits.

## Alternative Costs and Value

The estimate of monetary value (benefits) of storage for municipal and industrial water supply is based on the alternative cost doctrine. In essence, this doctrine assumes that the minimum of storage in the federal multiple-purpose project is equal to the cost of the most reasonable alternative which prudent planners might develop in the absence of the project.

It has been shown that, in addition to the yield from Cooper Reservoir, the full utilization of all other reasonable sources will be required to meet total anticipated water demands. Therefore, the selection of alternatives reduces to a single-purpose, water-supply-only reservoir at the Cooper project site.

By adaptation of cost estimates prepared for the Corps of Engineers, [17] the construction cost of a single-purpose dam to yield 76 mgd is 8 million dollars. This is equivalent to an annual capital cost of $373,000, assuming an economically useful life of 50 years and a non-federal interest rate of 4 per cent.

Adding to the capital cost an estimated $43,000 annually for operation and maintenance, the cost of the alternative (and hence the value of storage in the project) is $416,000 per year. At full utilization of a capacity of 76 mgd, this will reduce to 1.5 cents per thousand gallons.

# IX. APPENDIX

## Chemical Characteristics of Sulphur River Near Cooper, Texas
## Chemical Analyses, in Parts Per Million, Water Year October 1958 to June 1959

| Date of Collection | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium + Potassium (Na+K) (Cal.) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved Solids | Specific Conductance (Micromhos) | Hardness as $CaCO_3$) Total | Hardness as $CaCO_3$) Noncarbonate | pH | Color | Per Cent Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1958** | | | | | | | | | | | | | | | | | |
| 10/1-10(8)* | 12 | | 43 | 4.6 | 25 | 151 | 32 | 14 | .5 | 3.2 | 218 | 348 | 126 | 2 | 7.9 | 30 | 30 |
| 10/11-20 | 9.8 | | 27 | 3.1 | 23 | 101 | 30 | 10 | .4 | 1.8 | 155 | 262 | 80 | 0 | 7.5 | 55 | 39 |
| 10/21-29,31 | 11 | | 34 | 3.7 | 25 | 125 | 29 | 14 | .4 | .5 | 179 | 302 | 100 | 0 | 7.5 | 55 | 35 |
| 11/1-14 | 11 | | 47 | 5.6 | 36 | 165 | 44 | 25 | .4 | .8 | 262 | 429 | 140 | 5 | 8.2 | | 36 |
| 11/15-17 | 8.4 | | 25 | 4.1 | 15 | 104 | 15 | 7.5 | .4 | .5 | 127 | 222 | 79 | 0 | 7.5 | | 30 |
| 11/18-20 | 10 | | 55 | 6.7 | 103 | 139 | 60 | 148 | .6 | 1.2 | 452 | 815 | 164 | 50 | 7.6 | | 58 |
| 11/21-30 | 8.2 | | 39 | 4.2 | 37 | 147 | 32 | 28 | .6 | 1.2 | 222 | 398 | 115 | 0 | 7.7 | | 41 |
| 12/1-15(7)* | 11 | | 38 | 3.7 | 35 | 128 | 40 | 26 | .5 | 2.5 | 236 | 374 | 110 | 5 | 7.6 | 65 | 41 |
| 12/18-30(8)* | 12 | | 46 | 4.6 | 42 | 164 | 52 | 24 | .4 | 1.8 | 276 | 439 | 134 | 0 | 7.5 | 35 | 41 |
| **1959** | | | | | | | | | | | | | | | | | |
| 1/5-19(13)* | 11 | | 33 | 3.2 | 47 | 108 | 40 | 46 | .4 | 5.0 | 243 | 427 | 96 | 7 | 7.4 | | 50 |
| 1/16 | 9.8 | | 33 | 4.1 | 124 | 93 | 32 | 180 | | 5.0 | 434 | 803 | 99 | 23 | 7.4 | | 73 |
| 1/20-31 | 11 | | 51 | 5.4 | 65 | 134 | 45 | 93 | | 2.0 | 360 | 606 | 149 | 39 | 7.5 | | 49 |
| 2/1,3-14 | 8.8 | | 52 | 6.0 | 64 | 154 | 45 | 84 | .4 | .8 | 354 | 606 | 154 | 28 | 7.9 | | 47 |
| 2/15-20 | 13 | | 31 | 2.9 | 19 | 98 | 29 | 10 | .5 | 6.3 | 160 | 264 | 89 | 9 | 7.8 | | 32 |
| 2/21-28 | 14 | | 44 | 4.6 | 28 | 145 | 39 | 18 | .4 | 5.9 | 242 | 374 | 129 | 10 | 8.0 | | 32 |
| 3/2-4 | 15 | | 52 | 6.3 | 32 | 176 | 47 | 20 | .4 | 4.2 | 264 | 435 | 156 | 11 | 8.1 | | 31 |
| 3/5,7-10,13-16 | 10 | | 32 | 3.5 | 19 | 107 | 29 | 9.2 | .5 | 3.5 | 160 | 268 | 94 | 7 | 7.6 | | 30 |
| 3/6 | 11 | | 36 | 2.7 | 33 | 122 | 40 | 20 | | 5.0 | 208 | 355 | 102 | 2 | 8.2 | | 41 |

*Number of samples composited.

EXHIBIT A-1

IX-2

Chemical Characteristics of Sulphur River Near Cooper, Texas
Chemical Analyses, in Parts Per Million, Water Year October 1958 to June 1959 (Continued)

| Date of Collection | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium + Potassium (Na+K) (Cal.) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved Solids | Specific Conductance (Micromhos) | Hardness as $CaCO_3$ Total | Hardness as $CaCO_3$ Noncarbonate | pH | Color | Per Cent Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1959** | | | | | | | | | | | | | | | | | |
| 3/11-12 | 13 | | 26 | 3.6 | 13 | 92 | 22 | 3.8 | .6 | 4.2 | 131 | 215 | 80 | 6 | 8.1 | | 27 |
| 3/17-31 | 9.6 | | 39 | 4.4 | 23 | 128 | 36 | 13 | .7 | 2.8 | 204 | 324 | 115 | 10 | 7.6 | | 30 |
| 4/1-4,6-10 | 11 | | 44 | 5.2 | 25 | 150 | 41 | 14 | .4 | 2.0 | 242 | 374 | 131 | 8 | 7.7 | 30 | 29 |
| 4/11-17 | 11 | | 51 | 6.1 | 23 | 179 | 36 | 12 | .4 | 1.0 | 228 | 393 | 152 | 6 | 7.5 | 40 | 25 |
| 4/18-21 | 12 | | 23 | 2.9 | 15 | 78 | 23 | 7.5 | .4 | 3.2 | 135 | 208 | 69 | 5 | 7.6 | 70 | 32 |
| 4/22-30 | 13 | | 38 | 5.0 | 24 | 133 | 34 | 14 | .4 | 2.0 | 195 | 330 | 115 | 6 | 7.7 | 60 | 31 |
| 5/1-8,10-11 | 13 | | 54 | 7.1 | 31 | 197 | 42 | 17 | .4 | 1.5 | 279 | 446 | 164 | 2 | 8.0 | | 29 |
| 5/12-20 | 10 | | 40 | 4.7 | 23 | 129 | 37 | 13 | .5 | 6.8 | 198 | 344 | 119 | 13 | 7.7 | | 30 |
| 5/21-30 | 9.6 | | 49 | 5.5 | 27 | 172 | 37 | 15 | .5 | 3.0 | 254 | 406 | 145 | 4 | 7.4 | | 29 |
| 6/1-8 | 13 | | 46 | 5.0 | 41 | 174 | 42 | 25 | .5 | 3.0 | 285 | 440 | 135 | 0 | 7.6 | | 40 |
| 6/9-21 | 12 | | 33 | 3.5 | 19 | 117 | 22 | 10 | .5 | 4.0 | 162 | 275 | 97 | 1 | 7.6 | 30 | 30 |
| 6/22,24-30 | 14 | | 34 | 3.0 | 18 | 120 | 22 | 7.2 | .5 | 5.1 | 163 | 267 | 97 | 0 | 7.5 | 45 | 29 |

EXHIBIT A-2

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